MULTI-MODE RADIO PICONET/SCATTERNET

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/228,850, entitled "Multi-mode, multi-media piconets/scatternets", having attorney docket No. TI-3159PS, and filed on August 29,2000.

TECHNICAL FIELD

This invention relates in general to the field of radio communications, and more specifically to a multi-mode radio frequency network.

BACKGROUND

Previous communication systems allow for communication between different devices using a single mode of transmission. For example, a device communicating to other electronic devices over a Bluetooth piconet or scatternet (Bluetooth is a protocol for

wireless communications over short distances developed by the Bluetooth Special Interest Group), or a portable computer communicating to a computer network using an Institute of Electrical and Electronic Engineers (IEEE) 802.11 (a or b) protocol, etc. Given the increased use of wireless communications in many everyday electronic devices (e.g., personal digital assistants (PDAs, portable computers, etc.) and the increased number of different communication protocols being used, a need exists in the art for a method and system which would allow a Bluetooth compliant device to be able to communicate using one or more other modes of communications, thereby allowing the device to communicate to some devices using the Bluetooth protocol, while communicating with other device(s) or the same device using another protocol, such as a higher speed IEEE 802.11 protocol or any one of a number of other communication protocols.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention, which are believed to be novel, are set forth with particularity in the appended claims. The invention, may best be understood by reference to the following description, taken in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIG. 1 shows a diagram of a multi-mode radio communication network in accordance with the invention.

FIG. 2 shows a time line of a master unit communicating to a first group of slave units using a first mode and to a second group of slave units using a second mode of communications.

FIG. 3 shows a scatternet wherein a slave unit communicates to a master unit located in a first piconet using a first mode of transmission, and to a second master unit located in a second piconet using a second mode of transmission in accordance with the invention.

FIG. 4 shows a scatternet wherein a device acts as a master in one piconet and as a slave unit in a second piconet in accordance with the invention.

FIG. 5 is a diagram highlighting timing synchronization between two modes in accordance with the invention.

FIG. 6 shows how synchronization between two modes is maintained at the physical layer in accordance with the invention.

FIG. 7 shows a timing diagram highlighting "within mode" synchronization in accordance with the invention.

FIG. 8 shows a timing diagram highlighting "across mode" synchronization in accordance with the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

While the specification concludes with claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better

understood from a consideration of the following description in conjunction with the drawing figure.

The present invention provides for a heterogeneous radio network where a master unit communicates using voice or data to a first group of slave units in a first mode of operation, such as a Bluetooth mode, and communicates to a second group of slave units in a second mode, such as an IEEE 802.11 (a or b) protocol, etc. The master unit maintains synchronization with the slave units in the first mode and periodically communicates with them while at the same time servicing slave units using the second mode of operation. The second communication protocol beside the Bluetooth protocol that can be used by the device in accordance with the invention can include for example the IEEE 802.11 protocol as mentioned previously, High Rate Bluetooth protocol, the Global System of Mobile Communications (GSM) protocol, General Packet Radio Service (GPRS), Wideband Code Division Multiple Access (W-CDMA) protocol, other wireless local area network communication protocols, etc., but is not limited to these protocols. The present invention teaches a technique whereby a device can synchronize its communications using the Bluetooth protocol and one or more other protocols in order to increase the usefulness of the device in question.

In FIG. 1 there is shown a system diagram of a radio network 100 in accordance with the invention. Radio network 100 includes a master unit 102 that communicates with two slave units 104, 108 using a first mode of communications (Mode 1), such as via a Bluetooth piconet 110, and is also able to communicate with a slave unit 106 using a second mode of operation (Mode 2) such as using an 802.11 protocol. Likewise in

accordance with the invention, slave units can simultaneously exchange voice/data in a scatternet wherein one or more piconets in the scatternet are Bluetooth piconets (mode 1) and one or more piconets use a different mode of communication (mode 2) with master 102. In FIG. 2, a time line showing an illustrative example of time slots in which the master unit 102 communicates in mode 1 (Bluetooth mode) during time slots 201, and in the IEEE 802.11 mode 2 during time slots 206 (or using any one of a number of other communication protocols) is shown. The mode 1 time slots 201 are further broken down into time periods 202 and 204. In time period 202, the Master 102 communicates with other Bluetooth devices such as slave units 104, 108 using Bluetooth paging, sniff, beacon, etc. modes. In time period 204, the master unit 102 selects a good 22 MHz band using the Bluetooth probe, listen and select functions. In time period 206, the master unit 102 communicates with salve unit 106 using the second mode of communication, for example, 802.11.

In accordance with the invention, slave units can be simultaneously exchanging voice or data in a scatternet wherein one piconet is a Bluetooth piconet (mode 1) and the other piconet is a higher speed mode of operation (mode 2). Referring to FIG. 3, there is shown a scatternet 300 comprising two piconets 302 and 304. In this scenario, a slave unit 306 communicates to a first master unit 308 in bluetooth mode (Mode 1) that is in the first piconet 302, and also communicates with a second master unit 310 that is operating in a second piconet 304. Other combination of the above scenario where a slave unit communicates to multiple piconets that are themselves multi-mode piconets are also possible.

In still a further embodiment, in FIG. 4 there is shown a master unit 406 that can be communicating to one or more slave units 406, 408 in a first piconet 402 using Bluetooth and another communication protocol (Mode 2), and at the same time function as a slave unit in a second piconet 404. In this scenario, device 406 acts as a Master in one piconet 402, and a slave unit in a second piconet 404, while communicating using multiple modes.

As has been shown above, the present invention provides for a device that can communicate not only using Bluetooth but also using one or more other modes of communications. As shown above, this multi-mode capability can be used across piconets and scatternets. Synchronization between all the different modes of transmission is maintained in a given piconet and across a scatternet comprising multiple piconets.

The synchronization between the different modes within a device is maintained as shown in FIG. 5. With the timing information in the device being shared in the multiple modes of communication. The timing information synchronization is maintained explicitly at the physical (PHY) layer to allow rapid mode switching within the piconet as shown in FIG. 6.

Regarding synchronization, synchronization packets in mode 2 (non-Bluetooth mode) can be "within mode synchronous", i.e., synchronous only in mode 2, and they stop when the master enters mode 1. Within mode synchronous is shown in FIG. 7, with synchronous packets occurring at time periods 702 and 706 while in mode 2, and no packets occurring in time period 704 while in the Bluetooth mode (mode 1).

Synchronization packets in mode 2 can also be "across modes synchronous" when the time between packets is larger than the time the master spends in mode 1 (Bluetooth mode). The same can be applied for synchronous packets in mode 1. In FIG. 8, there is shown a time line highlighting "within mode synchronous packets". Synchronous packets occur in time periods 802 and 804.

While the preferred embodiments of the invention have been illustrated and described, it will be clear that the invention is not so limited. Numerous modifications, changes, variations, substitutions and equivalents will occur to those skilled in the art without departing from the spirit and scope of the present invention as defined by the appended claims.

What is claimed is: